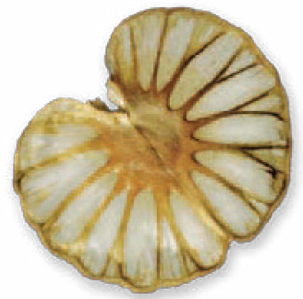


Samara



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MSB team members from Zambia, Mozambique and South Africa share best practice in herbarium voucher preparation as part of the regional Seed Conservation Techniques course in Zambia.



Photo: Roberta Hope, RBG Kew

Building the National Seed Collection in Zambia: Three years of partnership

Zambia is rich in plant diversity, with over 6,000 plant species and endemism at 5.3% (Phiri, 2005; Golding, 2002). Sadly, it is also cited as recording one of the highest deforestation rates across the continent.

Mpande Sichamba (Research Scientist – Forestry Research Division)

We are currently experiencing annual forest loss of between 300,000 and 400,000 ha (ILUA, 2008). Strengthening our national capacity and building a national collection of seeds from our indigenous flora is of utmost importance.

In 2018, Zambia's Ministry of Lands and Natural Resources – Division of Forestry Research (MLNR–DFR), with RBG Kew, developed an initial project, 'Developing a National Seed Collection Programme for

Zambia'. With modest investment into existing infrastructure we have made significant progress and can boast that Zambia now hosts a National Seed Collection of indigenous flora, held to internationally recognised standards.

We set a three-year target to make 540 seed collections from at least 450 priority species. During this initial project period (2018–2020/21), thanks to the commitment and enthusiasm of our small project team at MLNR–DFR, we have exceeded all expectations. We are so grateful for the financial support from players of People's Postcode Lottery; I hope you can share our pride in what we have achieved to date. Today, our National Seed Collection holds 653 collections from 572 species. Most of these collections are duplicated in the Millennium Seed Bank as part of our collection management strategy and are viewable on the Millennium Seed Bank Partnership (MSBP) Data Warehouse.

We've made some exciting and important collections, including securing seed from 41 species recorded by the IUCN as CR, EN or VU (IUCN, 2016), 27 CITES-listed species (including many orchids and euphorbias) and 14 commercially important timber species, such as *Pterocarpus tinctorius* (mukula) and *Guibortia coleospermum* (muzauli or rosewood). Nearly half (40%) of all our collections are useful herbal and medicinal plants, such as *Cassia abbreviata* (munsokansoka or long-pod cassia) and *Harpagophytum procumbens* (devil's claw).

Story continues on page 2



Working together with another project, we have secured millions of seed from many of the overexploited edible orchids of Zambia. We have a traditional delicacy called 'chikanda', a sort of cake made from ground orchid tubers, which Zambians cannot get enough of! We are continuing to develop strategies to make sure we can continue this tradition in a sustainable way.

We are passionate botanists here in Zambia and working as part of the MSBP has also been about meeting new botanists across the country and across our borders. With our neighbouring MSB partners across Southern Africa we are looking forward to playing our part in growing a strong regional seed conservation network.



Development of seed germination protocols during the regional training course hosted by MLNR-DFR. (Photo: Christopher Saluhandu)

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A message from Elinor Brehm

(Senior Research Leader, Seed Conservation, RBG Kew)

The UN Conference on Climate Change (COP26, in Glasgow) and the Conference of the Parties to the Convention on Biological Diversity (COP15, in Kunming) provide a political focus on, and global engagement with, the twin crises of climate change



Photo: Jon Spaul

Mauvoisin, Switzerland, August 2018.

and biodiversity loss. This topical issue of *Samara* focuses on contributions to global and national conservation initiatives by the Millennium Seed Bank Partnership (MSBP), and I am very excited to read about the work that partners have been doing in this area and to celebrate their achievements.

The MSBP has always contributed to the delivery of global and national plant conservation, previously through the Global Strategy for Plant Conservation, and now under the UN Sustainable Development Goals. It has been fabulous to see everyone across the MSBP rise to the challenges set and use their expertise and enthusiasm to ensure a future for plant diversity. I believe that this partnership has helped define

what can be achieved through international cooperation and collaboration in this sphere, and it is a privilege to be working with so many talented and committed people. As a community we have a strong voice in advocating for plant conservation, and communicating this need to a global public – and we will continue to make a difference for every plant on the planet.

I am looking forward to working with you to continue to conserve plant species, focusing on those with the greatest need; to increase the use of our collections and help develop native seed supply solutions to meet restoration and reforestation needs; and to deliver training and technology to improve conservation outcomes for seed collections.

A message from Monique Simmonds

(Deputy Director of Science, RBG Kew)

I am very pleased to report that the Millennium Seed Bank Partnership (MSBP) is a key element of Kew's new Science Strategy. I am also very honoured to be involved more closely with the MSBP and never in my wildest dreams thought that would happen! However, the Millennium Seed Bank (MSB) is not new to me. I remember helping Roger Smith and others make the pitch to different funders back in the 1990s. These funds enabled the MSB to be established. Since then, I have witnessed the incredible journey of the MSBP to today, when it is considered by many to be 'the largest and most important *ex situ* conservation project in the world'. We are now on a journey within the MSBP to not only continue saving quality seeds, but also to increase the use of seeds

being saved. As with most organisations, the MSBP will be setting targets for what success will look like in 2025 and we would welcome your thoughts on this.

Over the last 20 years our partners have witnessed the huge challenge it has been to collect a proportion of the world's seed. However, with the impact of climate change and changes in land use having drastic impacts on plant diversity, we feel that it is increasingly important to link collecting with a purpose. For example, collecting seeds from species that support hypothesis-based research on traits such as drought tolerance or disease resistance, or collecting seeds from species that could contribute to nature-based solutions – this is where our focus should be. I look forward to working with

you all on this journey and am sure through your work the global importance of the MSBP will go from strength to strength.



Monique Simmonds in the Princess of Wales Conservatory at Kew Gardens.

Photo: RBG Kew

A scientific approach to plant conservation in Armenia

Anush Nersesyán & Astghik Papikyan (Institute of Botany of the Armenian National Academy of Sciences)

Armenia is part of the Caucasus Biodiversity Hotspot region and despite being the smallest country in the South Caucasus region, it nevertheless holds more than half of the region's plant diversity. The A. Takhtajyan Institute of Botany of NAS RA is the lead scientific organisation in Armenia tasked with documenting and conserving the Armenian flora. Generations of Armenian botanists from the Institute have helped create a multivolume monograph, *Flora of Armenia* (1954–2010), and the Institute is always actively involved with *in situ* and *ex situ* conservation initiatives.

Within the Institute of Botany, *in situ* studies assessing the current state of endangered plant species in Armenia are carried out by staff from the Department of Conservation of Genetic Resources of Armenian Flora. With partner organisation Nature Heritage NGO, they have also contributed global IUCN Red List assessments as part of the Darwin Initiative project titled 'Enhancing rural Caucasian community livelihoods through fruit and nut conservation' (2018–2021). Dr A Nersesyán, head of the department, is among

the authors of the Red Data Book of Armenia (Tamanyan et al., 2010). The staff are committed to reintroducing threatened species back into the wild; for example, following work with Botanic Gardens Conservation International (Nersesyán, 2019), staff are propagating *Sorbus hajastana* seedlings, a Caucasus endemic, to facilitate reintroduction back into the wild.

The Seed Bank of Armenian Flora (SBAF) was established in 2011, with support from the Millennium Seed Bank Partnership and the Berlin Botanic Garden and Botanical Museum, and leads a variety of *ex situ* conservation initiatives. The SBAF holds collections from over 870 taxa, including 80 species included in the Red Data Book of Armenia (roughly 17% of Armenia's threatened plant species). Collections are routinely tested and seedlings grown on and planted within the Institute's living collections in the Armenian Biodiversity Information and Education Center ('Ecoepicenter'), which holds nationally important living collections – including more than 300 species from the Armenian flora, 54 of which are threatened (Nersesyán et al., 2020).



Photo: Nature Heritage NGO

Nature Heritage NGO team (left to right: Alexandr Rudov, Anush Nersesyán and Astghik Papikyan) during a collecting expedition.

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Ex situ conservation of wild seed and living collections: Endemic, endangered and economic plants of Bhutan

Kezang Tobgay (National Biodiversity Centre, Serbithang, Ministry of Agriculture and Forests)

For a long time, humankind extensively plundered and pillaged nature, all in the name of development. The bottom line was humankind's gain, nature's loss. Then, slowly but certainly, we learnt the value of conserving nature and its constituents. The Global Tree Seed Bank Programme is a global initiative for securing the future of at least 3,000 of the world's rarest, most threatened and most useful trees. In Bhutan, seed conservation efforts and Phase 3 of the Programme are in full progress with wonderful support from the Millennium Seed Bank and the Garfield Weston Foundation. Phase 3 aims to build on and expand

the achievements of Phases 1 and 2 through a further project. This conservation initiative provides support in managing the National Biodiversity Centre's gene bank for the conservation and preservation of the genetic diversity of endemic, endangered and economic use species from all the districts of Bhutan.

All plant specimens gathered, either as seeds or as living plants, were deposited at the National Biodiversity Centre, Bhutan. The collected seeds are also planted at the Royal Botanical Garden, National Biodiversity Centre, which specialises in the propagation and multiplication of Bhutan's

threatened flora. The Royal Botanical Garden in Bhutan promotes habitat restoration, serving as a living repository of the plant genetic diversity for conservation and research, and

as a rescue centre for rare and threatened species. The garden currently holds a living collection of more than 800 species of plants and focuses mostly on the native plants of Bhutan.



Team members from the Bhutan National Biodiversity Centre scale a mountain during a seed-collecting expedition, collecting *Primula* seed (*Primula umbratilis* var. *alba* and *R. pogonophyllum*) at Kyitsugang, Dangchu.



The rare and endemic *Rhododendron pogonophyllum* was rediscovered for the first time since 1937 during a seed-collecting expedition in June 2021 by National Biodiversity Centre.

Photos: Kezang Tobgay

Kew ash dieback disease research focuses on conservation and propagation of tolerant trees

Isabel Negri, Vicky Philpott & Owen Blake (RBG Kew)

The ash tree (*Fraxinus excelsior*) is the third most common tree in British woodlands, providing habitat and resources to at least 953 other species (Mitchell et al., 2014). Its strong and elastic timber is used for furniture making, and ash trees naturally also play a role in sequestering carbon. Being such an important species ecologically and commercially, it is perhaps not surprising that in Norse mythology, the Yggdrasil (the sacred tree of life, said to support the universe) was none other than a giant ash tree.

However, this resourceful pioneer species is highly threatened by the invasive fungus *Hymenoscyphus fraxineus* (ash dieback, previously *Chalara fraxinea*). Since only 1–5% of ash trees appear to show some resistance to ash dieback (Kjær et al., 2017; McKinney et al., 2014), research is focusing on the conservation and propagation of tolerant individuals. With this goal in mind, the UK Ash Collecting Project and the Living Ash Project are currently underway at the Millennium Seed Bank (MSB).

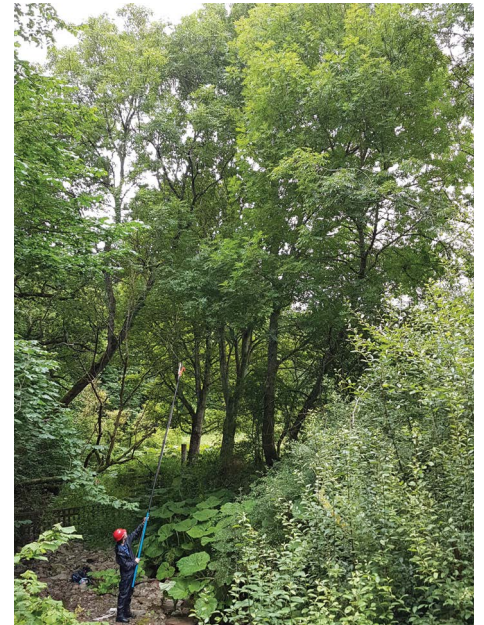
The UK Ash Collecting Project, funded by players of People's Postcode Lottery, seeks to enhance and expand the research value of the genetically and geographically diverse *ex situ* collections of ash, already conserved at the MSB through the UK National Tree Seed Project. This will be achieved by targeted seed collecting from tolerant ash trees in ancient natural woodland in eastern areas of the UK. Across these areas, ash dieback has been present for long enough to inflict high pressure on the species, therefore making it possible to identify those individuals that display some tolerance to the disease. In addition to this, surveying

of previously collected trees will allow us to assess their tolerance and add valuable information to the collections already at the MSB. Tolerance assessments used are based on several phenotypic scoring systems such as those of McKinney et al. (2011) and Stocks et al. (2017), where crown dieback is graded as a percentage of canopy lost, in conjunction with other dieback related symptoms.

Tolerance scoping was conducted in July through to September, with tissue samples being taken to allow genetic markers of tolerance to be identified. Trees identified as tolerant from the phenotypic assessment and with seed will be revisited in the autumn for collections to be made.

The Living Ash Project (LAP), funded by Defra, aims to identify and propagate tolerant ash. Forest Research, the Future Trees Trust and Fera Science are collaborating with RBG Kew on different aspects of this objective. In the nursery at Wakehurst, an LAP trial has begun on the propagation of ash from cuttings. If a successful protocol for this can be created, it will be essential in producing more ash dieback-tolerant trees.

Different soil types, rooting hormone concentrations and the inoculation with mycorrhizal fungi are all being tested in the experiment on a total of 720 cuttings. Symbiotic mycorrhizal fungi have already been shown to prompt root growth in cuttings of other tree species, such as Scots pine (*Pinus sylvestris*, Niemi et al., 2000). It will be interesting to find out whether this or other treatments will help ash cuttings to produce roots, getting a step closer to restoring ash woodlands at a later stage.



UK Ash Collecting Project Officer Owen Blake collects leaf material and data from potentially dieback-tolerant trees in the Scottish Borders (top) and North York Moors (bottom).



The Living Ash Project trial of ash vegetative propagation from cuttings.

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Seed collecting with partners and volunteers across South Africa

Naomi Mdayi, Sibahle Gumede, Fergy Nkadimeng & Victoria Wilman (Millennium Seed Bank Project South Africa)



Photo: MSBP South Africa

Ntsakisi Masia and Sibahle Gumede collecting tree species in KwaZulu Natal, South Africa.

The Millennium Seed Bank Project (MSBP) South Africa is extremely grateful to the many partners and volunteers who work with us and are often essential in enabling the team to collect and obtain special seed collections.

Partnering with external stakeholders allows access to locations, but also provides extra protection, field knowledge and assistance when needed. Described below are a few examples where recent collaborations during lockdown led to conservation successes.

Due to the dangers that come with Big Five game reserves, there has been little seed-collecting activity within them. However, MSBP South Africa is now covering the most dangerous areas in the country to make sure all plant species are banked, and Sibahle Gumede and Fergy Nkadimeng faced this challenge while collecting in Kruger National Park and Shambala Private Game Reserve earlier this year. Surrounded by lions, elephants, rhinos, leopards and buffalos (the Big Five), it was a nerve-wracking experience, but thankfully an armed ranger was always present to ensure their safety.

The trip resulted in 51 species collected, 21 new to MSBP. During collecting, the MSBP used the opportunity to train the rangers accompanying them. Fascinated by cut testing to check seed quality, the rangers realised there is more to seed collecting than just 'stripping the fruits', said Jacques Blihnault (Manager at Shambala). The rangers were also encouraged to join platforms like iNaturalist, which helps both the reserve managers and MSBP to keep track of plants occurring inside the reserve.

During lockdown, the team had to stop – but the plants didn't. With so much rain in the Eastern Cape Province from late the previous year, many plants flowered and set seeds, and unfortunately, some of these were missed. However, the beauty of nature is that everything has its time, and although some were missed, many other interesting plants were found. Using locality information shared by Ellie Goossens (a citizen science volunteer with Custodians of Rare and Endangered Wildflowers, CREW), MSBP seed collector Sibahle Gumede and the Kwelera National Botanical Garden Tourism Monitors searched for *Cyclopia longifolia*, a Critically Endangered species. With GPS coordinates available, they thought it would take just a few minutes – big mistake! With temperatures rising above 33°C, the search ended up taking hours.

Amongst many interesting plants collected that day were seeds of *Cullumia cirsioides*, a Vulnerable species only known from five locations and threatened by future forestry. Although the thorns of this plant didn't make picking fruits and cleaning the seed easy, knowing that the species is now backed up and conserved through seed banking makes it all worthwhile. Collaboration between CREW and MSBP has made plant searching easier and fun, and having the chance to search for plants with plant lovers from all over the province, after months of being restricted, was a great blessing.

Also during lockdown, MSBP South Africa was invited to visit Buffelskloof Nature Reserve in the north of Mpumalanga Province (Lydenburg) by Barbara Turpin (Herbarium

Manager), as well as Mountainlands Nature Reserve in Mbombela by Delia Oosthuizen. Sixty collections were made in these reserves from April to June 2021, including 28 that have never been banked, and three threatened species: *Helichrysum lesliei*, a habitat specialist, with fewer than 2,500 mature individuals remaining; *Indigofera hybrida* (VU); and *Senecio triodontophyllus* (VU), which was rediscovered in 2008 at one location. Barbara Turpin and Delia Oosthuizen assisted the MSBP team with locating these species, collecting seeds, and also identifying some of the species. All these relationships provide reassurance that plant conservation is in safe hands, and that more will be achieved by having one vision – conservation.



Photo: MSBP South Africa

Fergy Nkadimeng collecting seeds and data of *Burkheya latifolia* in Buffelskloof Nature Reserve, June 2021.



Sibahle Gumede teaching MSBP volunteer Siphesihle Ngwendu how to press herbarium specimens. Photo: MSBP South Africa.



Photo: MSBP South Africa

Sibahle Gumede was mesmerised by the size of this amazing *Brunsvigia grandiflora* that she came across while doing field work in Vernon Crookes Nature Reserve in the Eastern Cape.

Conserving the native plants of Greece

Costas A. Thanos (National and Kapodistrian University of Athens Seed Bank) & Aisyah Faruk (RBG Kew)

Greece contains one of the richest and most diverse floras in Europe and the Mediterranean Rim. Nearly 5,900 plant species and 7,000 taxa (species and subspecies) grow here, and around one quarter of them are endemic.

Threats to Greek phytodiversity are greater than ever, with land use changes (agriculture, urbanisation, tourism), overgrazing, deforestation, soil degradation and climate change affecting many parts of the country. The ongoing assessment of the conservation status of all Greek plants estimates that up to 2,000 taxa fall within an IUCN risk category. To combat impending biodiversity loss, numerous *in situ* and *ex situ* conservation initiatives are currently being undertaken.

It is estimated that only 30% of the Greek flora is currently conserved in the form of seed accessions, both in-country and abroad. In 2022, a collaborative project between the National and Kapodistrian University of Athens (NKUA) and the Millennium Seed Bank Partnership plans to collect, bank and conduct research on seeds of native plant species from mainland Greece. The NKUA Seed Bank was established in 1991 and is the oldest seed bank of native plants in Greece. Today, it holds 727 seed accessions from 403 plants native to Greece and Cyprus, most of them rare and threatened. In addition to *ex situ* conservation, the NKUA Seed Bank is also involved in several *in situ* conservation projects, conducts research on germination, and runs education and training events for students and staff related to various aspects of plant conservation.

In the first year, the project will aim to collect and conserve 160 taxa, focusing on key areas across Greece, such as Sterea Ellas (Central Greece) and the Peloponnese. These areas are well known for being some of the richest floristic regions in Greece for local and national endemics, alongside Crete. However, in contrast to Crete, they are both relatively under-represented within seed bank collections. We will prioritise species based on their threatened status and/or those missing from existing *ex situ* collections (e.g. *Veronica oetaea*). In addition to seed collecting, the project also aims to increase overall capacity of seed conservation through the delivery of an in-country training course in 2022. Finally, the project will initiate research on seed germination ecophysiology of orchids found within the country. The project is graciously funded by the A. G. Leventis Foundation, players of People's Postcode Lottery and The Steel Charitable Trust.



Seeds of *Biebersteinia orphanidis*; the inset (top left) shows a just-germinated seed after its seed coat was nicked at the region opposite to the micropyle. Previously thought to be extinct in Greece, this plant was rediscovered in the 1990s and is currently threatened by grazing and land-clearing.

Photo: C. A. Thanos



Reseeding *Veronica oetaea*, a critically endangered annual, growing only in a few temporary ponds on Mount Oeta (Central Greece).

Photo: S. Oikonomidis



Collecting seeds of *Campanula merxmuellieri*, a vulnerable, strict endemic chasmophyte of the Aegean (July, Skyros Island); bottom right: the plant in flower (late May).

Photo: A. Kaltsis

Tree seed collecting in Papua New Guinea

Gibson Sosanika (Bulolo University College, Papua New Guinea University of Technology)



Photo: Gibson Sosanika

Hernandia ovigera, an endemic species, in Baitabag forest.

Native tree species collection in the rainforest was challenging but exciting in 2019. When visiting several villagers – the indigenous forest owners – it was clear they initially considered seeds of forest tree species to be less important. Traditionally, subsistence farmers have developed and been practising vegetable seed preservation since Holocene periods (Denham, 2014) as part of their agricultural practices.

However, they were curious and came with me to collect wild seeds and fruits in the forest. We worked for two weeks dissecting and getting to know various types of seed arrangements in fleshy and dry seed capsules. It was impressive to see various structures and shapes when opening up an unseen world of seed physiology in the forest.

The first phase of wild tree species collections between low- and high-altitude rainforest highlighted this as an area needing intricate work to conserve wild species

seeds, in a country where most attention is given to commercial tree species.

Seeds in this part of the forest are yet to be carefully sampled and prepared for preservation, both nationally and abroad in seed bank vaults, but this is an important first step for species recovery, where events such as climate change can alter the growth and survival of natural forest species.

With this research, I am looking forward to establishing a seed storage laboratory for a large volume of collections for tree species and other vegetative species on the eastern half of New Guinea.

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Kew's input into the 2021 global environmental conventions

China Williams & Vicki Harrison-Neves (RBG Kew)

High expectations rest on crucial decisions to be made at global meetings taking place this year. Delayed by the pandemic, the UN Biodiversity Convention (CBD COP15) and the UN Conference on Climate Change (UNFCCC COP26) both meet to take urgent action on the twin threats of climate change and biodiversity loss.

Parties to the Biodiversity Convention convene in two stages. First, virtually, in October 2021, when the Kunming Declaration was adopted, calling on countries to commit to transformative change at all levels (business, industry, government, banking etc.). Second, in person, in Kunming, China in May 2022, where they will agree the details of a new, much-needed Post-2020 Global Biodiversity Framework. Kew scientists and international partners have been supporting their governments to develop the current draft, which proposes 21 targets for 2030 – including a commitment to protect 30% of the world's lands and waters by the year 2030 (the '30 by 30 initiative').

Mindful of the global failure to meet the Aichi Biodiversity Targets set out ten years ago, it is crucial for Parties to look harder at methods of implementation. It is clear

that scientific expertise is key. Kew's Nature Map Earth project, our work on the sampled Red List, Protected Area designation and management, the recent 'Ten golden rules for reforestation' paper, and standard setting on access and benefit sharing, all provide guidance (find out more about these projects at kew.org). Further decisions on funding and the contested issue of digital sequence information will also be addressed.

Meanwhile, this November in Glasgow, the UK hosted COP26 – the 26th meeting of the UN Framework Convention on Climate Change (UNFCCC) – where world leaders renewed their commitments to, and set out specific action towards, becoming net zero by 2050, and keeping global temperature rises within 1.5°C of pre-industrial levels.

Kew's focus here was to highlight the crucial role that nature can play in addressing the climate crisis, how this is intrinsically linked with biodiversity loss, and ways that the two challenges, and their solutions, can be tackled together. We were involved in discussion panels and in creating a 'nature-based solutions' themed garden within the UN's Pavilion in Glasgow. Kew scientists were also on hand to help explain the power of nature – plants in particular.



Photo: RBG Kew

Costa Rican President Carlos Alvarado Quesada (second left), accompanied by First Lady Claudia Dobles Camargo (far left), talks with (from right to left) Kew's Director of Science, Alex Antonelli, Chair of the Board of Trustees, Dame Amelia Fawcett, Director of Kew, Richard Deverell, and Head of Government Affairs, Vicki Harrison-Neves at the COP26 Climate Summit in Glasgow.

Follow Kew's involvement at both these conferences by joining virtual events – see kew.org and our social media channels.

Find out more about the meetings at cbd.int and ukcop26.org.

TISTR: Community seed bank for conservation and utilisation in Thailand

Pongsakorn Nitmee & Jakkrit Sreesaeng (TISTR)

Thailand is one of the world's biodiversity hotspots, with more than 20,000 species of plants found in the country. In recent years, the rate of natural resource destruction and over-exploitation, the spread of invasive species and climate change have had a negative effect on this biodiversity, resulting in population and genetic losses.

The Thailand Institute of Scientific and Technological Research (TISTR) is working on the conservation and sustainable utilisation of plants, algae, microorganisms and fungi to transfer technology and innovation to industry and community enterprises, and to promote economic, social and environmental utilisation for a sustainable society and bio-based economic growth.

Lamtakhong Research Station is a focal point of research and development in agriculture and the conservation of biodiversity under TISTR and seeks to promote sustainable utilisation of plant biodiversity. Lamtakhong Research Station has established two glasshouses for the botanical garden and the TISTR Community Seed Bank for *ex situ* conservation. The short-term (4°C) and long-term (-20°C) storage rooms are capable of conserving more than 10,000 seed accessions. The mission of the TISTR Community Seed Bank is to collect and conserve plant biodiversity including wild species, crop wild relatives, native species and landraces. Our current research focus is on indigenous species seed collecting in the Sakaerat Biosphere Reserve, which is one of four Biosphere Reserves in Thailand. TISTR is part of the Millennium Seed Bank Partnership, but we have only just started operating a community seed bank so are

continuing to develop our research expertise and to explore the appropriate technology for tropical species seed banking. Therefore, we are keen to collaborate with all relevant institutes to increase our capacity in terms of *ex situ* conservation and the development of restoration research.

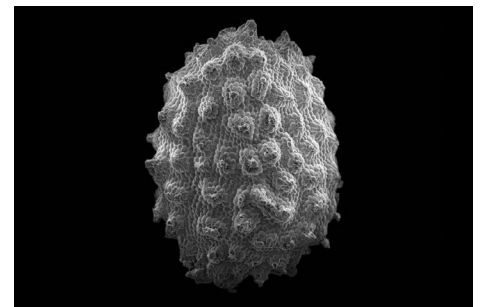


A group photo of TISTR, DOA and NSTDA staff in Mae Hong Son province.

All photos: TISTR



Solanum virginianum, crop wild relative in Thailand.



Impatiens spectabilis seed (endemic to Thailand).



Impatiens parishii, native to Myanmar and Thailand.



Two members of staff from TISTR and Dr Kate Hardwick, RBG Kew, catching tree seeds.



TISTR seed bank.



TISTR seed bank.

The MSB Tree Seeds Programme in Madagascar

Stuart Cable, Tim Pearce (RBG Kew) & Vonona Randrianasolo (KMCC)

The Millennium Seed Bank (MSB) programme in Madagascar is part of the Garfield Weston-funded suite of projects, collectively called the Global Tree Seed Bank Programme. Our partner in Madagascar is the Silo National des Graines Forestières (SNGF) and the work is coordinated by the Kew Madagascar Conservation Centre (KMCC). Mamy Andriamahay (SNGF) and Vonona Randrianasolo (KMCC) manage the work with their respective teams, from organising collecting trips and training collectors (including a network of communities and NGOs), to seed processing, data management and duplicating seed material between SNGF in Antananarivo and the MSB in the UK.

Madagascar has a deforestation rate of over 2% per year, resulting mostly from shifting cultivation in both the humid and dry regions. In response, the government has developed an ambitious forest restoration and afforestation strategy, planning to plant 40,000 ha per year over the next decade. SNGF is at the centre of these efforts and our project will bank and make available the seeds of the most threatened tree species, as well as building a knowledge base to inform national restoration efforts.

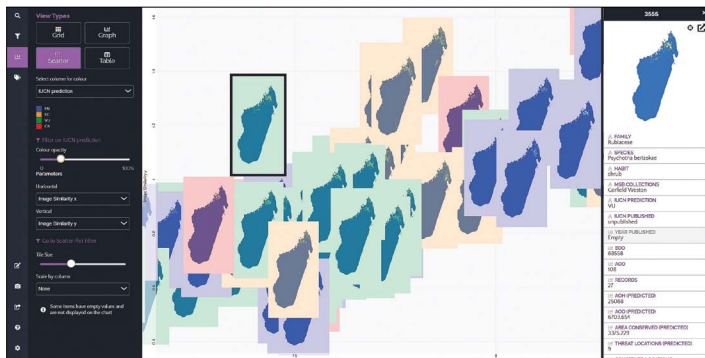
With almost 6,000 seed collections already secured *ex situ* since 2000 by the partnership, this project has added further collections of over 400 tree species. Of these, 83% are endemic to Madagascar and 62 are classified as Endangered or Critically Endangered on the IUCN Red List. The KMCC team has undertaken over 1,000 IUCN Red List assessments of trees alongside other institutions, contributing to the 'Red List of the Dry Forest Trees of Madagascar' recently published by Botanic Gardens Conservation International. The work is ongoing but concludes that 60% of dry forest trees are threatened with extinction.

Our project has developed a red-listing tool, deepRED Madagascar, which covers 4,300 endemic species of trees and shrubs from throughout Madagascar. It includes detailed distribution maps and IUCN assessments generated by machine-learning algorithms, which predict that over 80% of the endemic tree flora may be threatened with extinction. The tool will also help the team to plan future seed-collecting trips and to inform other restoration and conservation projects as we incorporate further ecological data, including environmental niches and the results of germination testing at the MSB. The team are also digitising herbarium vouchers to help with identification of the seed collections and plan to publish several of the new species discovered during the work.



Photo: Solofo Rakotoarisoa

The iconic baobab *Adansonia grandidieri* (IUCN Endangered) has been collected several times for the project.



deepRED Madagascar clusters species with similar distributions, enabling comparison of IUCN Red List assessments and targeting of priority species for seed-collecting trips.

Zavamaniry Gasy Plants of Madagascar
Kew Madagascar Conservation Centre (KMCC)

Stats

Totals	Most Observations	Most Species	Most Observed Species
47464 Observations	frank 3002 observations	frank 1024 species	Sage 466 observations
4447 Species	davidrabehitra 2538 observations	esrakotoarisoa 930 species	Elephant's Foot Plant 193 observations
710 People	onjalalaha 2413 observations	onjalalaha 862 species	Fony Baobab 181 observations
	frank 2252 observations	landyrital 718 species	Traveller's Palm 153 observations
	corakotoarisoa 1945 observations	nomor 693 species	Song of India 129 observations

Members 232 members

About

All observations for the Plants of Madagascar welcome. We aim to massively increase plant data for research, conservation and development with the help of citizen scientists.

Embed a widget for this project on your website



The MSB team cleaning seeds.

The team uses iNaturalist to record tree distributions and phenology.

Photo: Vonona Randrianasolo

Georgia celebrates 15 years of plant conservation with the MSBP

Tsira Pantsulaia & Tinatin Barblishvili (National Botanic Gardens Georgia)

The wild native flora of Georgia comprises 185 vascular plant families, 1,048 genera and 4,275 species.

Georgia is part of the Caucasus Biodiversity Hotspot region, with a high level of endemism and species richness. Of all species present, 21% (900) are local endemics; among them about 600 species are endemic to the Caucasus and about 300 are endemic to Georgia (Davliandize et al., 2018).

Since 2005, a working group from the Department of Plant Conservation of the National Botanical Garden of Georgia (NBGG) and the Institute of Botany at Ilia State University have been active partners in the Millennium Seed Bank Partnership (MSBP). Over the past 15 years, seeds and herbarium specimens from more than 1,859 taxa, belonging to 108 families and 505 genera, have been collected from the wild and conserved at the National Seed Bank of Georgia. These collections represent more than 43% of Georgia's flora and include 375 endemics of the Caucasus and 160 endemics of Georgia.

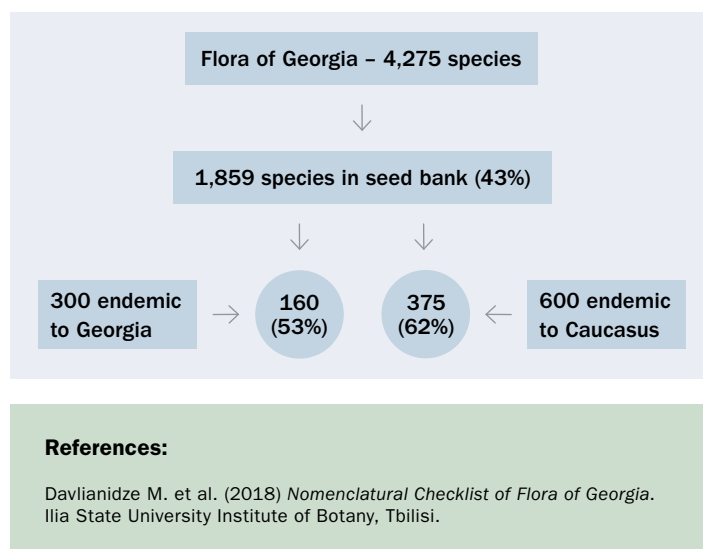
They also include collections of important plant groups. For example, 112 collections of economically important species and their crop wild relatives are stored at the seed bank following completion of a Darwin Initiative-funded project targeting wild fruit and nut species in the country. These collections, together with community collaboration during the project, further the objectives of the International Treaty on Plant Genetic Resources for Food and Agriculture in relation to 'conservation, documentation, sustainable use, and *ex situ* collections of food and agriculture resources', and support the Convention on Biodiversity strategic goals. Overall, these *ex situ* collections contribute towards Georgia's National Biodiversity Strategy and Action Plan, which in turn contributes to Target 8 of the Global Strategy for Plant Conservation.

Collections stored at the National Seed Bank of Georgia are routinely tested for viability and to generate germination protocols. Collection data, together with comprehensive geographical, botanical and habitat information, are managed within a BRAHMS database and where seed numbers allow, collections are duplicated to the Millennium Seed Bank and made available for use by researchers and practitioners.



A photo montage of seed conservation activities in Georgia.

Photo: S. Peradze



Biodiversity conservation in Azerbaijan

Valida Alizade (Institute of Botany, Azerbaijan National Academy of Sciences)

Azerbaijan is one of the hotspots of biodiversity in the Caucasus region, with high endemism, as well as a significant number of relict and economically important plant species. Conservation of plant diversity and its sustainable use are the main goals of researchers at the Institute of Botany, Azerbaijan National Academy of Sciences (IoB, ANAS). Accordingly, the IoB develops activities in collaboration with institutions and organisations recognising the importance of biodiversity conservation. In recent years, programmes have aimed at a comprehensive study of wild plants, including populations of threatened species, and their *ex situ* conservation, widely using the molecular phylogenetic approach and methods of mathematical forecasting. These activities are carried out in collaboration with leading international organisations such as Missouri

Botanical Garden, Berlin Botanical Garden and Botanical Museum, the International Union for Conservation of Nature, the Millennium Seed Bank Partnership, Botanic Gardens Conservation International, the Intergovernmental Platform on Biodiversity and Ecosystem Service, and the Plant Collecting Collaborative.

As a member of the World Flora Online Consortium, the IoB has developed a checklist of the flora of Azerbaijan within the nomenclature of the World Flora Online platform. The first and second editions of the checklist of the vascular plants of Azerbaijan were published in 2019 and 2020 respectively.

One of the IoB's ultimate goals is to conserve the country's threatened flora in *ex situ* living or seed collections, sampled from wild populations across Azerbaijan. Currently, the

seed bank stores seed collections representing 30% of the country's threatened flora that are included in the Red Data Book of Azerbaijan. The stored materials are available for research or use for reintroduction, restoration, and molecular or phylogenetic studies.



Collecting seed from *Calligonum bakuense*, a coastal species endemic to Azerbaijan.

Photo: Aida Dadashova

FRAME to train next-generation restorers of tropical forest ecosystems



Co-funded by the Erasmus+ Programme of the European Union

Stephen Elliott (Forest Restoration Research Unit, Chiang Mai University)

As the [UN Decade on Ecological Restoration gathers momentum](#), the need for well-educated foresters has never been greater. [Global tree-planting schemes](#), to combat climate change and biodiversity loss, will only succeed if they are [based on sound ecological science](#). Consequently, the [FRAME project](#) (Forests, Climate Change Mitigation and Adaptation: Higher Education Cooperation in the Mekong Region) will train a new generation of foresters, capable of implementing genuine forest ecosystem restoration.

Co-funded by the European Union's Erasmus+ programme, the project links two European universities (the University of Helsinki, Finland and the Czech University of Life Sciences Prague, Czechia) with four South-East Asian universities (in Thailand, Kasetsart University and Chiang Mai University, and in Lao PDR: Savannakhet University and Souphanouvong University). The project is developing tools to build capacity for forest restoration and sustainable management in the South-East Asian partner countries.

[Chiang Mai University](#) is developing courses at three levels: a BSc-level introduction to ecological restoration, an MSc course in restoration research and a MOOC (Massive Open Online Course) with course materials based on the original outputs of the university's [Forest Restoration Research Unit \(FORRU-CMU\)](#).

[Kasetsart University](#) is establishing graduate courses on social aspects of forest restoration and the application of new technologies. Novel teaching tools, including virtual reality, are being tested.

[Souphanouvong University](#) is developing graduate courses on forests and climate, ecotourism and forest restoration. The university is also establishing its own version of FORRU on campus, with technical support from FORRU-CMU – an excellent example of south-south collaboration.

[Savannakhet University](#) is concentrating on commercial aspects, with graduate courses on wood analysis, processing, economic valuation and dendrology.

Watch the courses evolve on FRAME's Facebook page: web.facebook.com/frameerasmus.



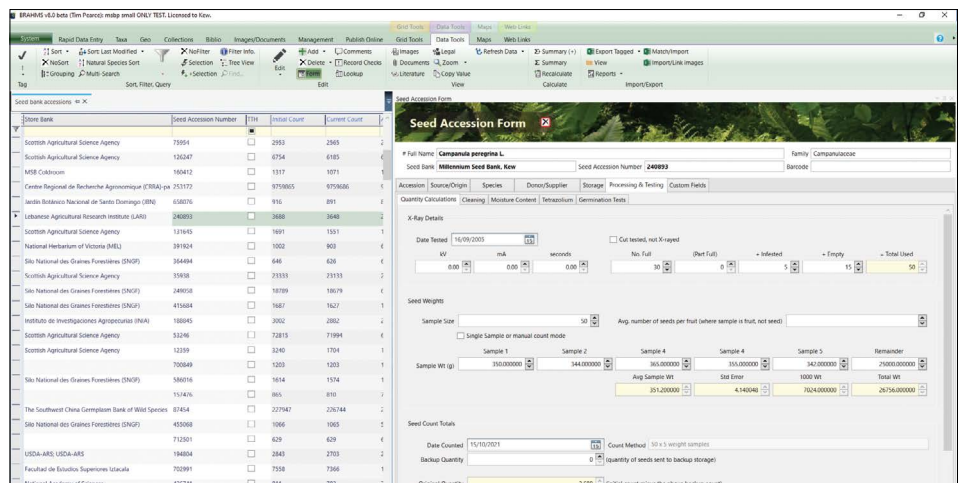
Photo: Stephen Elliott

A composite image of a restoration site just after tree planting. Use of drone technologies to monitor forest restoration is a major feature of the new courses being developed under the FRAME programme.

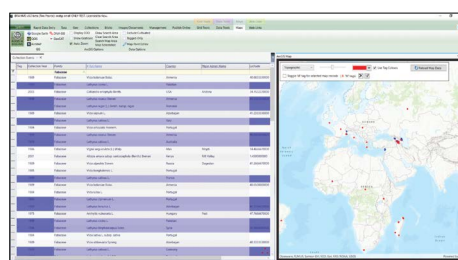
BRAHMS 8 update – Seed module in advanced stages of development

Naomi Carvey & Tim Pearce (RBG Kew)

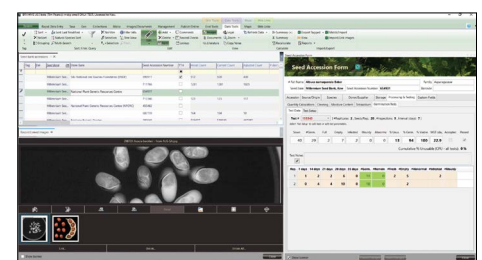
The eagerly awaited seed module in BRAHMS 8 is now well underway with the seed table, germination tables and automated calculations scripted, and an initial round of user acceptance testing completed. A showcase of the new BRAHMS 8 seed module will be scheduled for later this year. Volunteers would also be welcome to try out the new seed module and provide feedback to help us get the best possible solution for the data management of seed bank collections and trait data. If you would like to be invited to the BRAHMS 8 seed module showcase event, to help with testing, or for more information, please contact Tim Pearce (t.pearce@kew.org) or your MSBP partnership coordinator.



A screenshot showing the user interface of the BRAHMS 8 seed module including dummy data.



A screenshot showing the mapping capabilities of the BRAHMS 8 seed module.



A screenshot of the germination testing and x-ray data storage options in the BRAHMS 8 seed module.

News

BBVA Foundation Award

The Millennium Seed Bank Partnership (MSBP) has received the Worldwide Award for Biodiversity Conservation and a prize of €250,000 in the 16th BBVA Foundation Awards for Biodiversity Conservation. The awards distinguish nature conservation initiatives based on the best scientific knowledge and pursuing outcomes of broad and lasting impact.

The judges considered the MSBP to be an exemplary initiative which reflects how cooperation without borders can advance nature conservation worldwide and successfully address the central challenge of preserving biodiversity.

The judging panel was particularly impressed by the MSBP's training capacity, a key element of the partnership which allows best practices, technology and ideas to be shared across the network.

Seeds of hope from Hiroshima

Since 2011 the Green Legacy Hiroshima Initiative (GLH), co-founded by Nassrine Azimi and Tomoko Watanabe, has been sharing the seeds and message of the *hibaku jumoku* (survivor trees) globally. The survivor trees are those that survived the atomic bomb dropped on the city of Hiroshima, Japan, on August 6, 1945, at the end of the Second World War. GLH collects and sends the seeds of these remarkable trees to botanic gardens, universities and symbolic sites worldwide, who grow them as a symbol of peace and hope for a world free of nuclear weapons for generations to come.

The Millennium Seed Bank (MSB) has been honoured to receive seeds from six of these tree species for long term conservation in their vaults. This is the start of an ongoing relationship which will see seeds from all the survivor trees backed up at the MSB, and some of them grown in the gardens at Kew and Wakehurst.



Seeds of *Ginkgo biloba*, *Ilex rotunda* and *Platanus orientalis* from the Green Legacy Hiroshima Initiative, just arrived at the MSB.

Photo: Hanna Oldfield, RBG Kew

Recent publications

Back from the Brink (2021) Ecology and Conservation Portfolios for *Adonis annua*, *Bromus interruptus*, *Filago pyramidata*, *Galeopsis angustifolia*, *Ranunculus arvensis*, *Silene gallica*, *Torilis arvensis*, *Valerianella rimosa*, *Veronica triphyllos* and *Veronica verna*. Available from <https://naturefbt.co.uk/the-projects/colour-in-the-margins/>

The Declaration Drafting Committee (2021) Kew declaration on reforestation for biodiversity, carbon capture and livelihoods. *Plants, People, Planet*. <https://doi.org/10.1002/ppp3.10230>

Widjaya, A.H., Latifah, D., Hardwick, K.A., Suhartanto, M.R. & Palupi, E.R. (2021) Reproductive biology of *Vatica venulosa* Blume (Dipterocarpaceae). *Biodiversitas*. 22: 4327-4337. DOI: 10.13057/biodiv/d221025

Breman, E., Ballesteros, D., Castillo-Lorenzo, E., Cockel, C., Dickie, J., Faruk, A., O'Donnell, K., Offord C.A., Pironon, S., Sharrock, S. & Ulian, T. (2021) Plant diversity conservation challenges and prospects – the perspective of Botanic Gardens and the Millennium Seed Bank. *Plants*. 10: 2371. <https://doi.org/10.3390/plants10112371>

Kereselidze, K., Lachashvili, N., Kikodze, D., Khutsishvili, M. & Schröter, A. (2021) *Tulipa biflora* Pall. (*Liliaceae*) – a new species for the flora of Georgia (South Caucasus). *Annals of Agrarian Science*. 19: 261-267. <https://journals.org.ge/index.php/aans>

New MSBP agreements

Country/territory	Partner	Start	Duration (years)
Australia	Botanic Gardens and State Herbarium, South Australia	July 2021	5
Georgia	Institute of Botany, Iliia State University	February 2021	10
Georgia	National Botanic Garden of Georgia	February 2021	10
Indonesia	Research Center for Biology, Indonesian Institute of Sciences & Research Center for Plant Conservation and Botanic Gardens, Indonesian Institute of Sciences	December 2021	5
Kyrgyzstan	The National Academy of Sciences of the Kyrgyz Republic	April 2021	5

MSB Dashboard	1st November 2021
Total collections	97,638
Total countries (including overseas territories)	190
Total families (excludes ferns)	351
Total genera	6,145
Total species	40,035
# of good seeds	2,429,843,554

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The next *Samara* will be published in March 2022 at brahmsonline.kew.org/msbp/Samara/ENewsletter. If you have a story or publication you would like to share in the e-newsletter version of *Samara*, please email the editorial team (samara@kew.org) by 31 January 2022.